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Publ. 36



Stereo Telemeters

District (with Base of 50 cm)

Diurno (with Base of 32 cm)



1599

CARL ZEISS JENA

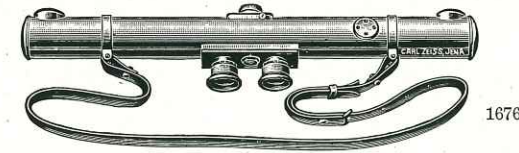
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Stereo Telemeter with Base of 50 cm "District".



Scale 1 : 10.

The small weight of this instrument and its low magnification renders it available for use in the hands. It is particularly suitable for the purposes of geographers, hunters, tourists, and official surveyors (for rough land surveying and sketch-mapping).

For military purposes we supply a distinct model ("Distact") having the same base.

Optical Data.

Base (being the distance between the centres of the objectives): 50 cm.

Telescope magnification: 8.3 diameters.

Initial stereoscopic ratio = $\frac{\text{base}}{\text{mean interpupillary distance}} = 7.7$.

Magnified stereoscopic ratio = initial stereoscopic ratio \times magnification = 6.4.

Clear aperture of the objective: 24 mm.

Diameter of the emerging pencil: 2.9 mm.

Light-transmitting power: $2.9^2 = 8.4$.

Angle subtended by the object: $2^\circ 52'$, i. e. 50 yards at a distance of 1000 yards.

Apparent field of view: $23^\circ 41'$.

Magnitude of the Errors of Observation.

Distance Metres	Mean Error of Observation Metres	Distance Metres	Mean Error of Observation Metres
200	1.4 (0.5)	600	13 (4.3)
250	2.2 (0.7)	700	17 (5.7)
300	3.2 (1.1)	800	23 (7.7)
350	4.3 (1.4)	900	28 (9.3)
400	5.6 (1.9)	1000	35 (12)
450	7.1 (2.4)	1500	79 (26)
500	8.8 (2.9)	2000	140 (47)
		3000	320 (107)

The bracketed figures indicate the limits of accuracy obtainable under very favourable conditions.

Stereo Telemeter with Base of 32 cm "Diurno".

This is a small instrument which is primarily designed for the use of hunters and tourists and suffices for measurements up to 500 metres. It is likewise available for approximately fixing the base for stereo-photogrammetrical surveys.

Optical Data.

Base (being the distance between the centres of the objectives):
32 cm.

Initial stereoscopic ratio = $\frac{\text{base}}{\text{mean interpupillary distance}} = 4.9$.

Magnified stereoscopic ratio = initial stereoscopic ratio \times
magnification = 20.

Clear aperture of the objective = 12 mm.

Diameter of the emerging pencil: 3 mm.

Light-transmitting power: $3^2 = 9$.

Angle subtended by the object: $6^\circ 20'$, i. e. 110 yards at a
distance of 1000 yards.

Apparent field of view: $25^\circ 12'$.

Magnitude of the Errors of Observation.

Distance Metres	Mean Error of Observation Metres	Distance Metres	Mean Error of Observation Metres
20	0.04 (0.01)	100	1.1 (0.4)
30	0.1 (0.03)	300	10 (3)
50	0.3 (0.11)	500	27 (9)
70	0.5 (0.2)		

The bracketed figures indicate the limits of accuracy obtainable under very favourable conditions.

Stereo Telemeters

are instruments for measuring distances, advantage being taken of the fact that two eyes, by reason of their mutual separation, have the faculty of seeing distant objects in their real solid form and so receive what is known as a stereoscopic impression.

The principle of Stereoscopic Telemetry.

The **Stereoscopic Telemeter** is based upon an idea suggested by the late engineer Mr. H. de Groussiliers, and, as put into being by us, consists essentially of a double telescope having widely separated objectives and containing in its field of view **artificial marks** corresponding to the various planes of the relief picture. By simply looking at an object through the telemeter eye-pieces an observer sees the distant object and the artificial marks apparently grouped in relief one behind the other at given distances and has no difficulty in identifying that point along the line of marks which corresponds to the distance of the object. To this end the marks are figured in conformity with their apparent distances, so that the process resolves itself into one of direct reading.

A detailed account of the construction of the stereo-telemeter will be found in the reprint of a paper read by Dr. C. Pulfrich of the Carl Zeiss Optical Works, entitled "The Stereoscopic Telemeter constructed by the Carl Zeiss Optical Works", Phys. Zeitschr. 1, p. 100. Copies of this paper may be obtained, on application, in German, English, or French.

From the surveyor's point of view the instrument is dealt with in the

Zeitschrift für Vermessungswesen, Vol. 30, 1901, p. 65 ("Über die Beurteilung der Raamtiefe und den stereoskopischen Entfernungsmesser von Carl Zeiss, Jena", by Dr. O. Hecker, of Potsdam).

The Advantages of the Stereo Telemeters.

The stereo-telemeter supplies by inspection immediate readings of the distances of **any object of whatever kind**, and the degree of accuracy is little affected by the nature of the object. It is accordingly suitable for use with rapidly moving or quickly disappearing objects, such as balloons, birds, etc.; objects having ill defined and irregular outlines, e. g. clouds, smoke, etc.; or those of small dimensions, such as the short projecting points of spires, etc.

The distance can be read without calculation and without any special adjustments.

Being a binocular relief telescope of a highly perfected type it supplies at once a picture in which distant objects appear clearly ranged one behind the other.

The instrument requires **one observer only.**

The **dimensions of width** of a distant object can be determined by a special scale fixed in the field of view.

As the result of experiments and practical experience covering a period of many years the instrument has been rendered remarkably immune from accidental derangements from mechanical and thermal causes. The body is carefully sealed so as to obviate the entrance of dust and moisture.

The Use of the Stereo-Telemeter.

From the nature of the instrument it follows that it cannot be used by persons with one eye more or less defective or disabled.

Stereo-telemeters cannot be used with immediate success by persons, generally more or less advanced in years, who have by practice or habit exercised one eye at the expense of the other, say by continuously working with the microscope, by rifle practice, wearing monacles, and so forth. Persons belonging to this category, when called upon to obtain a sharp view of a distant object, either with the unaided eyes or when looking through a binocular telescope, are wont to either close the habitually neglected eye or to systematically suppress the impressions received by that eye.

The task of training such persons for work with a stereo-telemeter consists solely in teaching them afresh to see with both eyes and to re-establish an aptitude for stereoscopic vision by continued and systematic practice with a binocular telescope or a stereoscope provided with appropriate stereoscope pictures*). In these cases much practice will be needed to develop a fine discriminating power between different distances along the line of sight, upon which the accuracy of the measurement largely depends, and without which a candidate cannot be regarded as a fully qualified operator.

Stereo-telemeters are available for immediate use in the hands of those who, like the majority of young persons, have had no occasion to exercise one eye much

*) The stereoscope picture with its inscribed scale, as provided by us, is well adapted for this purpose.

more than the other. In fact, a quarter of an hour's tuition suffices to render an operator belonging to this class conversant with the use of the instrument. Naturally even with these operators several days practice is required to enable them to discriminate accurately and promptly between different positions along the line of sight.

The question as to the extent to which a person may or may not be eligible for work with the stereoscopic telemeter should, if possible, be decided by an examination of the candidate's eyes by an oculist. Ordinarily, a trial with the instrument itself will settle the question.

Choice of Station.

It is always advisable to employ a stand when learning to use the instrument and also during operations from a permanent station. The height of the telemeter should be such that the operator may be able to observe with his head and body in an entirely unconstrained position. The instrument should not be allowed to become warmer at one end than the other. When taking observations from a closed space care should be taken that the temperature within the room may not differ excessively from the temperature of the external air. *On no account should observations be made through a glass window.*

Method of Focussing.

The instrument should first be turned towards a bright portion of the sky. A good focus should then be obtained *for either eye separately* in such a manner that the scale in the eyepiece on the right may appear absolutely sharp to the right eye, whilst the left eye should see equally sharply the scale in the left eyepiece. To obviate the unsatisfactory proceeding of screwing up one eye the objectives should be covered up alternately. The eyepieces are provided with scales graduated in terms of diopters, which enables an operator having once adjusted the eyepieces or knowing the refraction of his eyes to reset them in an instant without trial. Spectacle numbers of the old inch system may be converted into diopters by the following formula:

$$\text{Number of diopters} = \frac{40}{\text{old spectacle number}}$$

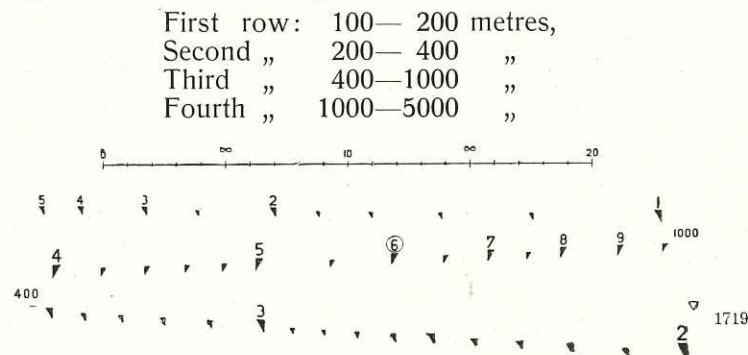
The Adjustment of the Distance between the Eyes.

Keeping the instrument directed against the bright sky the distance between the eyepieces should be adjusted by turning the knob between the objectives, that is to say on the side facing the distant scene, until the stadia scale assumes the appearance of a solid zigzag line floating in space. *Stereoscopic observation, far from fatiguing, produces a pleasant effect, whilst the first impression is agreeably startling.* The correct distance between the eyepieces need only be determined once and may then be read off the interocular distance scale situated between the eyepieces, by means of which the proper setting may be reproduced at any subsequent time.

The correct distance between the eyes may very conveniently be found with the aid of the **Interpupillary Distance Gauge**, which is supplied free with the telemeter. Observers having eyes further apart than 60 mm ($2\frac{2}{3}$ inches), when using the Infantry Telemeter, will only be able to obtain an approximately correct reading; in this case the adjustment should be corrected by trial so as to secure the best stereoscopic effect.

The Stadia Scale.

The marks of the stadia scale in the case of the "District" Telemeter are arranged in four rows extending in zigzag fashion back into space.



To be able to use the instrument expeditiously the operator should be quite conversant with the interpretation of the scale in all its parts.

The first row has been omitted in the above diagram.

The arrangement of the stadia scale in the "Diurno" Telemeter is shown on the plate appended to this booklet.

First row:	20—25 metres,
Second "	25—50 "
Third "	50—100 "
Fourth "	100—500 "

How to Read Distances.

The first efforts in telemetry should be confined to isolated and striking objects having the bright sky for a background such as lightning conductors, flagstuffs, tree tops, and such like. After a little practice it will be found easy to deal with objects having a less favourable background. The beginner is advised to adopt the following method: He should direct the telemeter **against the bright sky** above the given object and not upon the latter itself. Looking into the telemeter and confining his attention to the stadia scale which appears to extend into the background, he should turn the instrument downwards, which may be conveniently accomplished by tilting it within its cradle mount. As soon as the distant object becomes visible in the lower part of the field the observer will at once obtain the desired effect, that is to say he will receive the impression of the stadia scale hanging like a solid body in the air above the object, and to obtain a reading it is only necessary to note that point on the stadia scale which appears to range itself into the plane of the highest point of the object.

After a little practice this point can generally be identified more or less precisely as soon as the object appears in the field of view. An operator who is not yet able to do so should begin with the nearest mark below, and not with a mark corresponding to a more distant point; he should then bring this mark close above the object, taking the most scrupulous care that **the mark may not actually cover the object** (see below). If he should recognize that the object is further away than the mark he should pass on to the next mark and proceed as before, and so on. The transition from one row to another should always be made from a lower to an upper row, never in the reverse order. In this manner he will find a mark which appears to be at the same distance as the object.

The object will in the majority of cases occupy an intermediate position between two marks, and to accurately determine its position along the line of sight the line which joins

the points of the inverted triangular marks should be brought up as near as possible to the highest projecting point of the object. If in this position of object and scale the instrument be moved slightly to and fro about the vertical axis of the cradle mount the object will appear to intersect the line joining the vertices of the triangular marks.

In the attempt to bring the object and the selected scale marks as close together as possible it frequently happens that the mark partly overlaps the object. This does not signify so long as the mark corresponds to a nearer point than the object. On the other hand, if the mark corresponds to a more distant point or to one at the same distance an inexperienced operator is liable to be deceived, whilst interpreting the relative positions of the mark and the object along the line of sight. This very superposition of the object and mark is apt to produce an exaggerated impression of the distance of the object, especially when this distance is great and the weather happens to be dull. In these cases the correct impression may be restored immediately by so shifting the mark over, or to the side of, the object that they may not overlap.

Observations in an unsteady atmosphere, e. g. across a plain on which the sun is shining, are not necessarily vitiated by the resulting tremor of the image. The object merely appears to change in rapid sequence its distance from the observer. In these cases the mean of extreme readings should be taken as the correct value. In bright sunlight it is advisable to use yellow moderating glasses.

How to Take Distances of Lights at Night and at Dusk.

When setting up the telemeter it is important to so arrange matters that the bright point may be seen without obstruction from either objective, as obstacles are liable to escape notice in the dark.

The leather case contains two illuminating screens, which should be attached to the cylindrical necks of the objective shutters in such a manner that their white sides may face each other. These screens should then be illuminated by a sufficiently bright light held from the back and at the middle of the instrument. It is advisable to first set the instrument with respect to the distant point light.

A light sufficient for the illumination of the two screens may be obtained in the simplest manner by using one or two burning matches. There is no objection to the use of a source of light of a somewhat excessive intensity, as the brightness of the screens may easily be moderated by moving the light away from the middle of the apparatus in the direction of the distant object.

This is best accomplished by an assistant, who should place himself on the object side of the telemeter and attend to the proper illumination of the screens.

The telemetrical operation is an extremely simple matter, since in the uniform illumination of the field of view the scale becomes at once a stereoscopic object, whilst the distant luminous point appears to be detached and hanging freely in the air. It is immaterial whether the observation be made in complete darkness or in twilight, since in the latter case the environments of the point light, though still visible under ordinary conditions, are entirely masked by the artificial illumination of the field of view and thereby rendered invisible to the observer's eye.

To Measure the Width of a Distant Object.

The width of a distant object is invariably measured with the aid of one eye only. For this purpose the stadia scale is surmounted by a horizontal scale which is divided into 20 equal parts in the case of the "District" Telemeter and into 50 equal parts in that of the "Diurno" Telemeter, each part signifying one yard for every 1000 yards of distance, or $\frac{D}{1000}$ yards at a distance of D yards, whilst the corresponding angle subtended at the eye by each scale division is $\frac{1^\circ}{17}$. The field of view may likewise be made the means of estimating dimensions of width and height. The diameter of the field of view is 50 yards per 1000 yards, or $2^\circ 52'$ in the case of the "District" Telemeter, and 110 yards per 1000 yards or $6^\circ 20'$ in that of the "Diurno" Telemeter. As seen stereoscopically the horizontal scale appears to be at an infinite distance, and the diaphragm is situated at an apparent distance of about 150 yards.

Readjustment of the Telemeter.

The telemeters are sent out completely adjusted. In the event of a permanent derangement becoming noticeable as the result of violent shocks or similar causes the operator will have no difficulty in recognizing and eliminating for himself the following two important faults. The readjustment should, however, only be undertaken by experienced operators.

1. Rectification of the Stadia Readings.

When the telemeter ceases to supply correct readings it may be readjusted with the aid of a measured distance. On the side of the instrument facing the object will be seen a movable cover inscribed with the letters *S* and *H* (Side and Height). When folded back this cover exposes two holes. The key supplied with the instrument should be inserted in the hole marked *S* and turned until the instrument reads the measured distance correctly. When it does so *in any one case* it will supply **correct readings for all distances**. The measured distance used as a standard should preferably be great, as in this case it need not be measured with the same degree of absolute accuracy as a short base. The point of infinity is not reached until the distance exceeds 50 miles in the case of the "District" Telemeter and 15 miles in that of the "Diurno" Telemeter.

The degree of accuracy with which the standard distance should be measured follows from the tables of errors given on pp. 3 and 4.

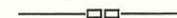
2. Rectification of the Altitudinal position of the Stadia Marks.

When the instrument is in perfect order the corresponding marks in the right and left fields should occupy the same horizontal level with respect to an object as seen in the telemeter. To test this requirement the telemeter should be placed upon the cradle of the stand or fixed in some other convenient manner. Having ascertained the distance of any striking object, the operator, whilst looking with **one eye** into the **left eyepiece**, should place the stadiam mark corresponding to that distance close to the highest point of the object by turning the telemeter body about its axis. Looking again with **one eye** into the **right eyepiece** he should see the stadiam mark occupying the same position relatively to the object. If this be not so the key should be inserted into the hole marked *H* and turned until the stadiam mark occupies a correct position. To make sure that the telemeter has not shifted its position in the mean time the adjustment should be once more verified in the left eye-piece. Errors in the altitudinal adjustment of the stadia marks do not necessarily falsify the readings, but if they are allowed to exceed a certain limit they may render it difficult to secure the stereoscopic fusion of the images with the result that the eyes may become fatigued and so lose their faculty of taking correct observations.

Packing and the Way of Carrying the Stereo Telemeters.

The Stereo-Telemeter "District" is supplied in a case which may be carried either over the shoulder or on the back. If the case shall be carried over the shoulder the spring-hooks are to fasten to the rings on the long-side. For carrying on the back the straps have to be passed through the loops on the backside and the spring-hooks to be fixed to the two loose rings below.

The Stereo-Telemeter "Diurno" contained as well in a case can be also carried on the back and over the shoulder. For carrying over the shoulder the two spring-hooks have to be fixed to the two rings above and for carrying on the back to the loose rings on the long-side.



Prices.

"District" Telemeter.

	Weight	Price	Codeword
Stereo-telemeter with Shoulder Strap	4 $\frac{1}{4}$ lb		
Substantial Brown Case with Shoulder Strap and all Accessories,	about 3 $\frac{1}{2}$ "		
	7 $\frac{3}{4}$ lb	M. 950	District
Sliding Tripod Stand with Gradle Mount	4 $\frac{1}{2}$ " "	50	Districto
Telemeter with Tripod Stand . .	12 $\frac{1}{4}$ lb	M. 1000	Distrigano

"Diurno" Telemeter.

	Weight	Price	Codeword
Stereo-telemeter with Shoulder Strap and Substantial Brown Case with Shoulder Strap and all Accessories,	about 5 lb	M. 500	Diurno

*The above Prices are strictly Nett for prompt Cash and for
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Stereo Telemeters

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